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(54) **DUST COLLECTOR FOR VACUUM CLEANER**

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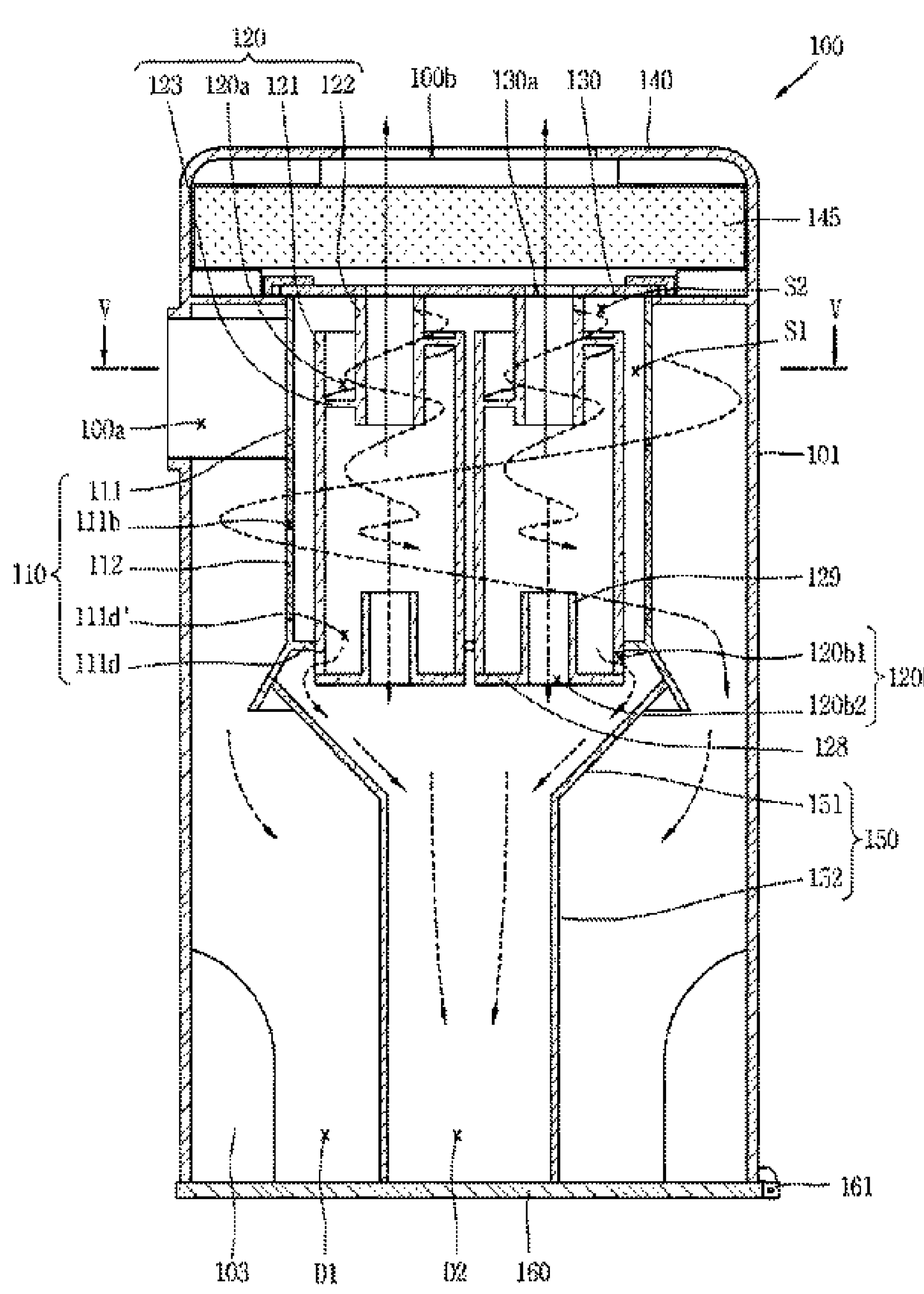
(57) **ABSTRACT**

A dust collector for a vacuum cleaner, including a first cyclone disposed within an outer case to filter out dust from air introduced from an outside thereof and introduce the air from which dust has been filtered out to an inside thereof, a second cyclone accommodated in the inside of the first cyclone to form a first space between the first cyclone and the second cyclone to separate fine dust from the air introduced to the inside of the first cyclone, and a guide vane spirally extended along an inner circumference of the second cyclone to induce rotational flow to the air introduced to an inside of the second cyclone through an inlet of the second cyclone via the first space, wherein the guide vane is integrally provided on the second cyclone.

17 Claims, 7 Drawing Sheets



(51) **Int. Cl.**

B01D 45/12	(2006.01)
B01D 45/16	(2006.01)
B04C 3/06	(2006.01)
B04C 5/26	(2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
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See application file for complete search history.

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FIG. 1

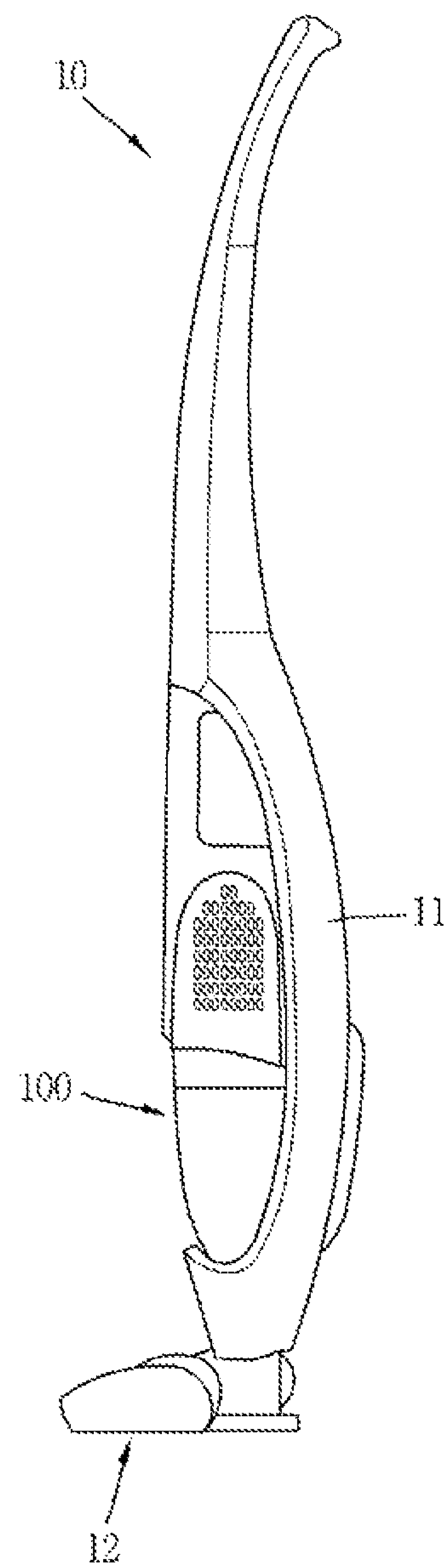


FIG. 2

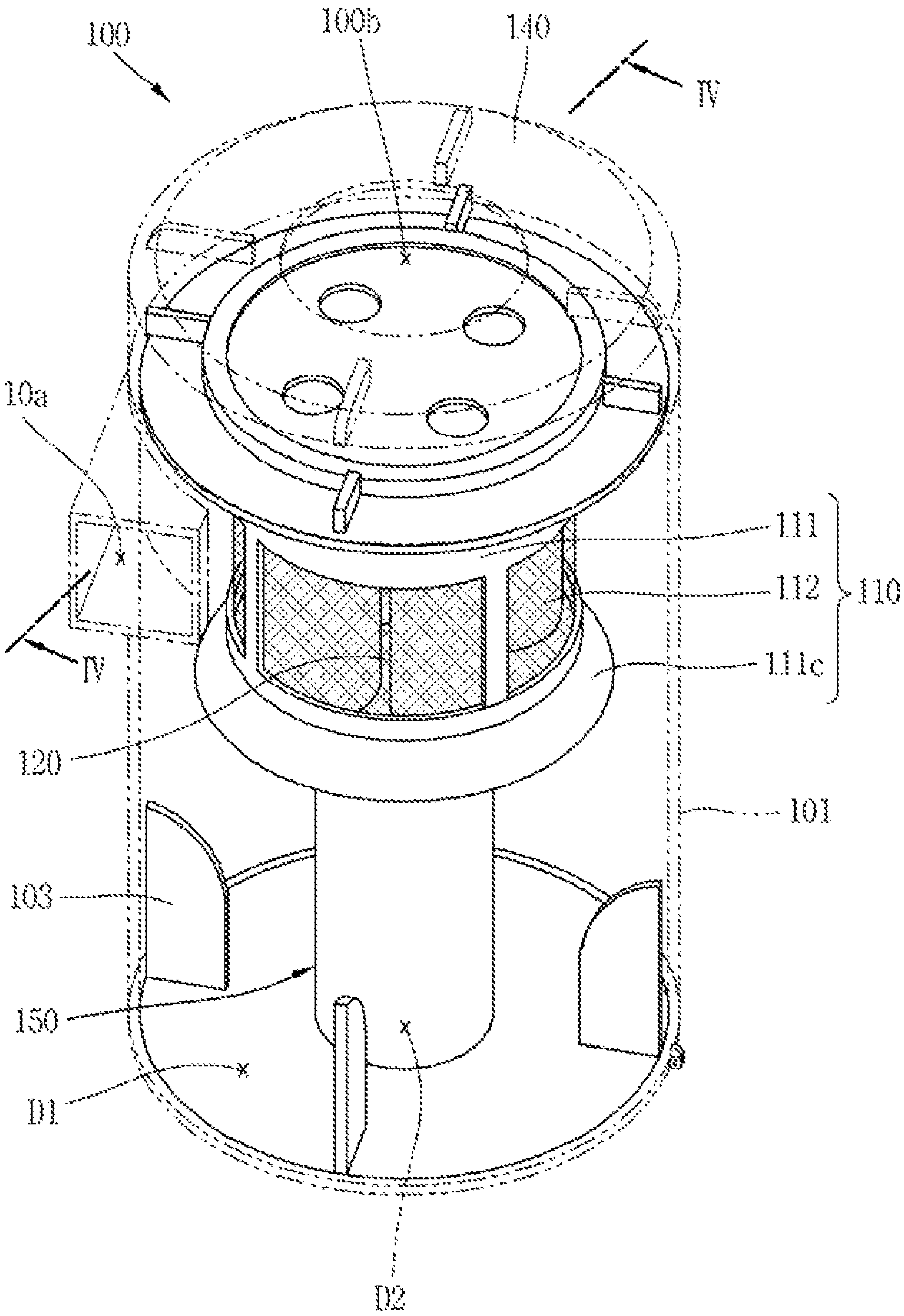
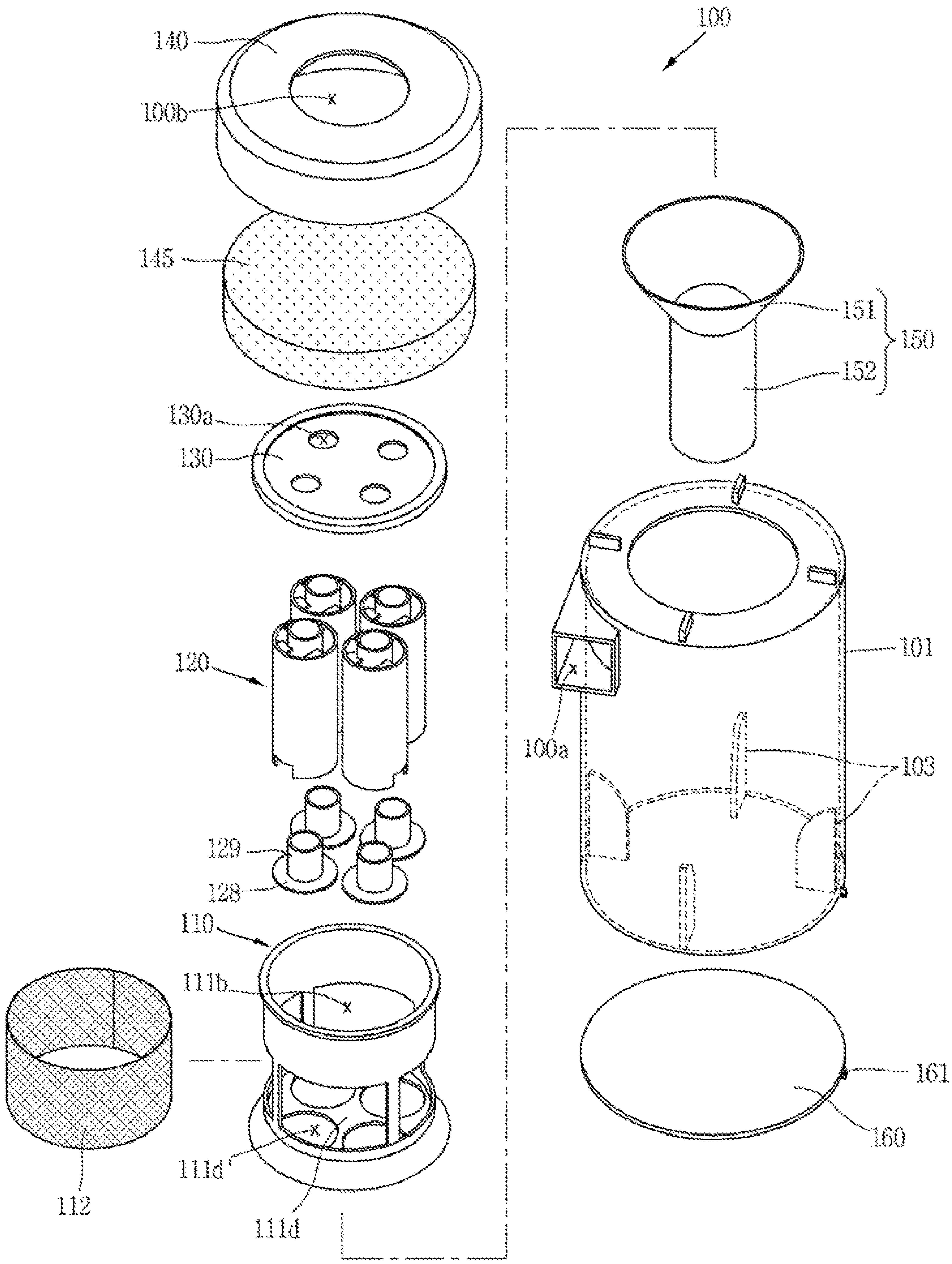


FIG. 3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140
100b
145
130a
130
120
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111b
111d
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112
151
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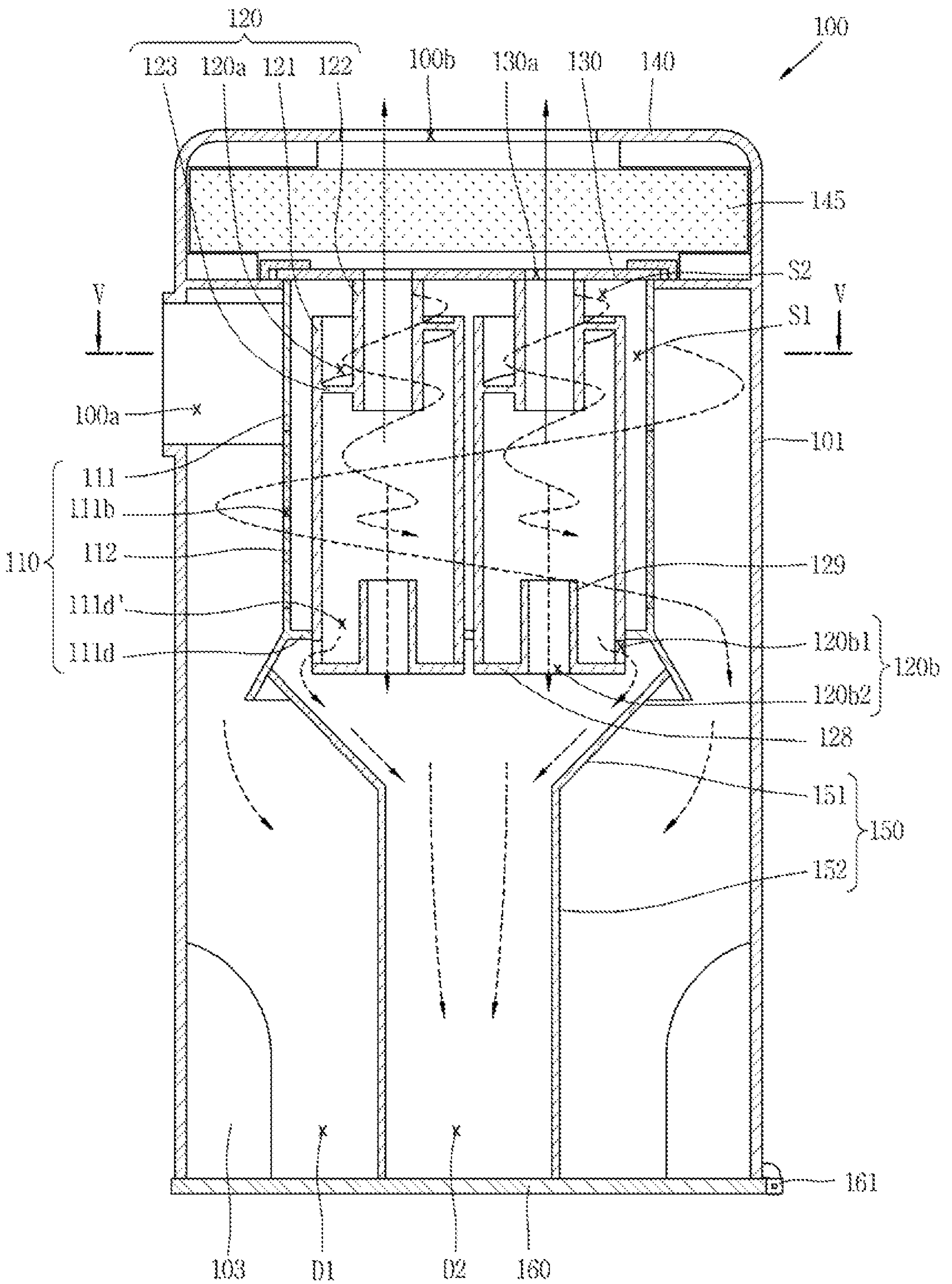
100a
103
161
160

FIG.4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123
120a
121
122
100b
130a
130
140
100
145
V
S2
V
S1
100a
101
111
111b
110
112
129
111d'
111d
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120b
120b2
128
151
150
152
161
103
D1
D2
160

FIG. 5

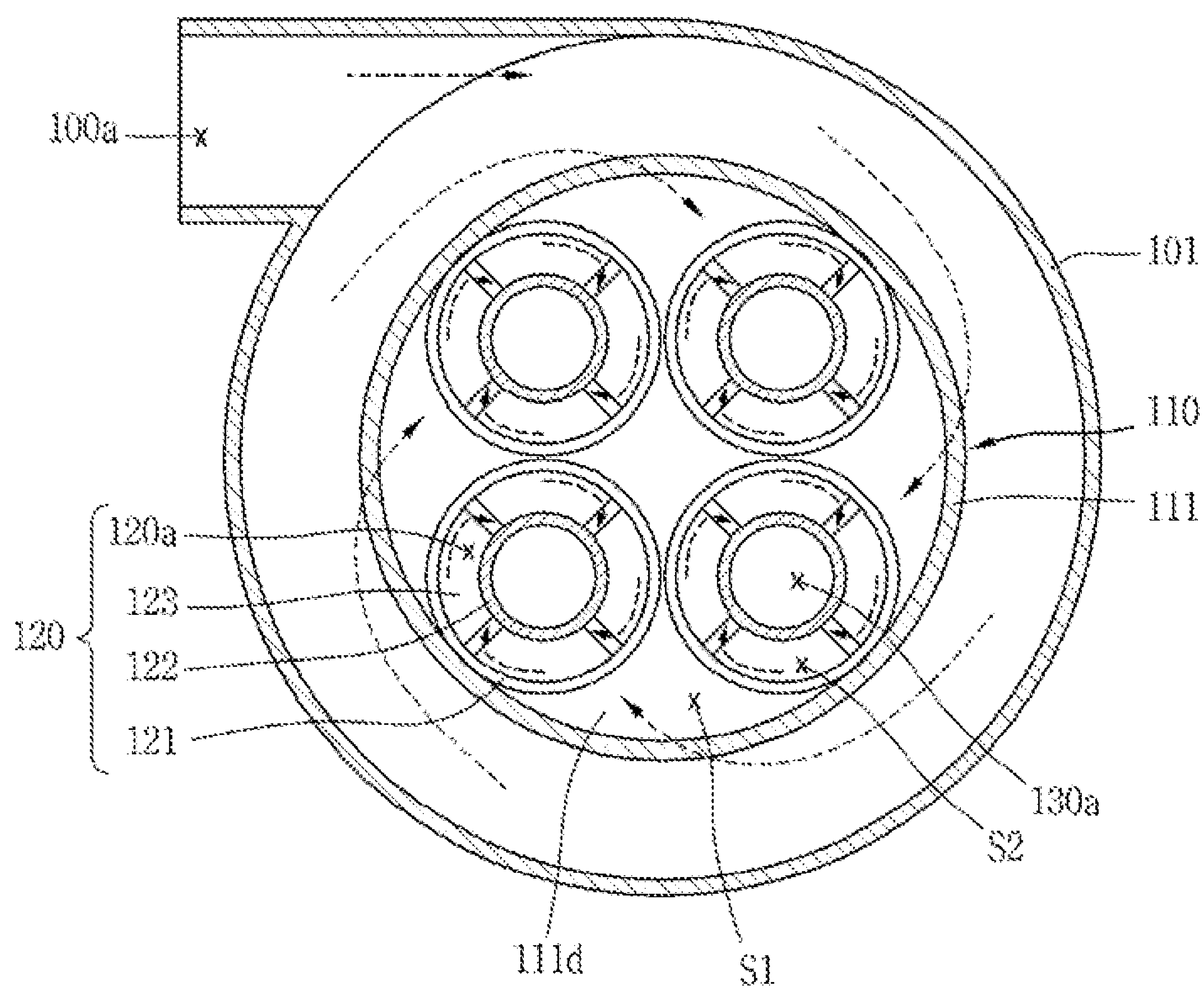


FIG. 6

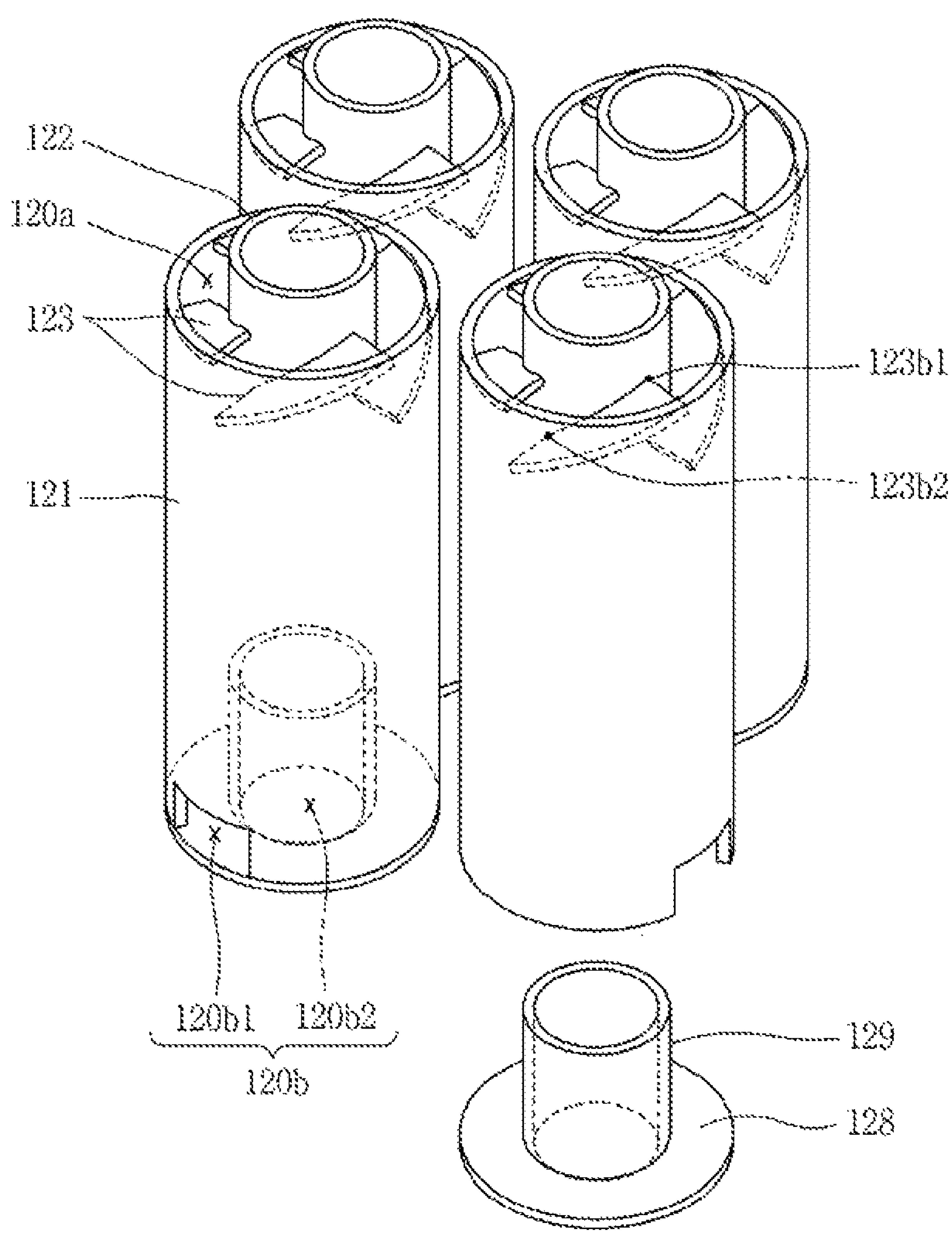
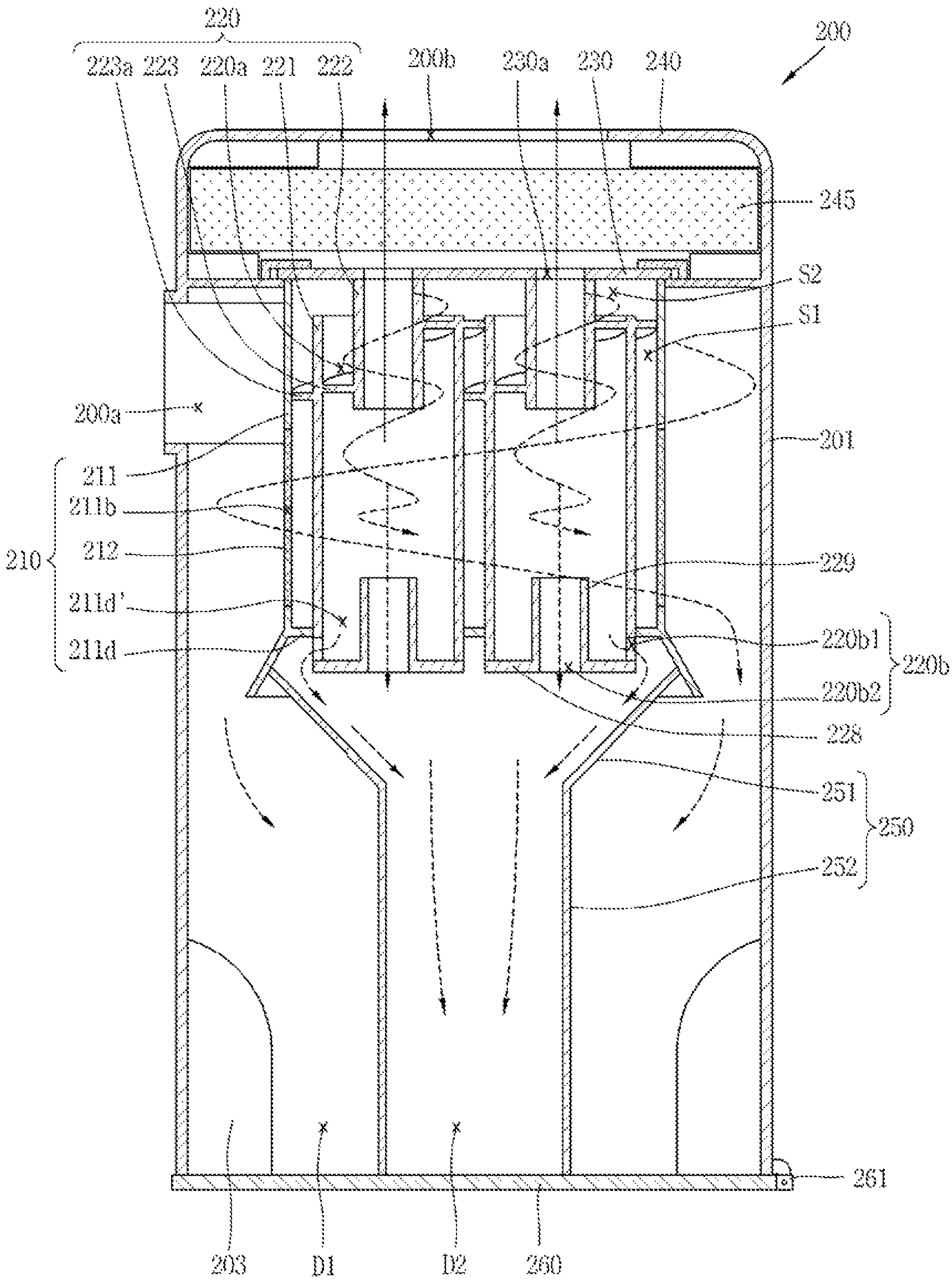


FIG. 7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200
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211b
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212
229
211d'
211d
220b1
220b
220b2
228
251
250
252
261
203
D1
D2
260

DUST COLLECTOR FOR VACUUM CLEANER

CROSS-REFERENCE TO RELATED APPLICATION(S)

Pursuant to 35 U.S.C. § 119(a), this application claims the benefit of earlier filing date and right of priority to Korean Application No. 10-2015-0008869, filed on Jan. 19, 2015, the contents of which is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

The present disclosure relates to a dust collector for a vacuum cleaner configured to collect dust and fine dust through a multi-cyclone.

2. Background

A vacuum cleaner is an apparatus configured to introduce air using suction power formed by a suction motor and separate dust or dirt from the air to discharge clean air. The types of vacuum cleaners may be divided into i) a canister type, ii) an upright type, iii) a hand type, iv) a cylindrical floor type, and the like.

The canister type vacuum cleaner is a vacuum cleaner mostly used at home, which is a vacuum cleaner with a method of communicating a suction nozzle with a body through a connecting member. The canister type may include a cleaner body, a hose, a pipe, a brush, and the like, and be suitable to clean a solid floor due to performing cleaning only with suction power.

The upright type vacuum cleaner may include a suction nozzle and a body that are integrally shaped. The upright type vacuum cleaner may include a rotary brush, and thus clean up dust or the like within a carpet, contrary to the canister type vacuum cleaner. However, vacuum cleaners in the related art have drawbacks as follows.

For vacuum cleaners having a multi-cyclone structure, each cyclone is vertically oriented, which may cause a problem of increasing the height of a dust collector. Further, the dust collector is designed to have a slim profile to solve such a height increase issue, thereby causing a disadvantage of reducing the volume of a space for collecting actual dust.

In order to solve the foregoing problem, a structure in which a second cyclone is arranged within a first cyclone has been proposed, but it is difficult to efficiently locate the second cyclone within the first cyclone due to interference between the guide passages of the second cyclone. Even when the second cyclone is arranged within the first cyclone, the number of second cyclones may be decreased to reduce suction power, thereby resulting in the deterioration of cleaning performance.

In the case of a typical multi-cyclone in the related art, as air introduced into the collector passes through the first cyclone, the flow speed of air decreases, thereby causing a problem in which air that has passed through the first cyclone is unable to be efficiently introduced into the second cyclone. Even though air that has passed through the first cyclone is introduced into the second cyclone, air introduced into the second cyclone does not have a strong rotational force, thereby causing a problem in the performance of separating fine dust from the introduced air.

In particular, a tangential inhalation type cyclone structure in the related art may be provided with a guide passage for tangentially introducing air and fine dust to an inside of the cyclone. The foregoing tangential inhalation type cyclone structure has low passage usability, and the size of the cyclone decreases due to the installation of the guide passage, thereby causing a problem of increasing the entire passage loss.

Furthermore, in case of the first and the second cyclone, air containing dust may move within a small space, thus resulting in a complicated structure as well as causing a problem of requiring a complicated manufacturing process. On the other hand, for cleaners in the related art, there exists a limit in providing the user's convenience during the dust discharge process. There are vacuum cleaners in which dust is blown away during the process of discharging the dust, as well as vacuum cleaners requiring a very complicated dust discharge process.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements, and wherein:

FIG. **1** is a perspective view illustrating an example of a vacuum cleaner according to an embodiment;

FIG. **2** is a view illustrating a dust collector according to an embodiment illustrated in FIG. **1**;

FIG. **3** is a view in which the internal major configurations of a dust collector illustrated in FIG. **2** are shown in a separate manner;

FIG. **4** is a longitudinal cross-sectional view in which the dust collector of FIG. **2** is cut and seen along line IV-IV;

FIG. **5** is a longitudinal cross-sectional view in which the dust collector of FIG. **4** is cut and seen along line V-V;

FIG. **6** is a view in which a second cyclone illustrated in FIG. **3** is shown in an enlarged manner; and

FIG. **7** is a longitudinal cross-sectional view illustrating an example of a dust collector according to another embodiment.

DETAILED DESCRIPTION

FIG. **1** is a perspective view illustrating an example of a vacuum cleaner **10** according to an embodiment. The vacuum cleaner **10** may include a power unit or system, a cleaner body **11**, a suction unit or component **12**, and a dust collector **100**. The power unit may be configured to receive power from an outside to supply power to an inside of the cleaner body **11**. The power unit may be a battery incorporated in the body or a power cable connected to the body.

The cleaner body **11** may include a fan unit or fan configured to receive power from the power unit to generate suction power. The fan unit may include a suction motor and a suction fan, and the suction fan may be connected to the suction motor and rotate according to the driving of the suction motor to generate suction flow and inhale outside air.

The suction unit **12** provided with a suction nozzle may be formed at a lower end portion of the cleaner body **11**. Air and foreign substances may be inhaled through the suction nozzle by suction power generated by the suction fan, and introduced into the dust collector **100**. The dust collector **100** may be configured to separate and collect foreign substances from the inhaled air, and discharge air from which dust is separated. The dust collector **100** may be detachably connected to the cleaner body **11**.

Hereinafter, the dust collector **100** according to an embodiment will be described in detail. The entire configuration of the dust collector **100** and the flow of air and foreign substances within the dust collector **100** will be described in FIGS. **2** through **5**. FIG. **2** is a view illustrating the dust collector **100** according to an embodiment illustrated in FIG. **1**, and FIG. **3** is a view in which the internal major configurations of the dust collector **100** illustrated in FIG. **2** are shown in a separate manner, and FIG. **4** is a longitudinal cross-sectional view in which the dust collector **100** of FIG. **2** is cut and seen along line IV-IV. FIG. **5** is a longitudinal cross-sectional view in which the dust collector **100** of FIG. **4** is cut and seen along line V-V.

A specific structure associated with the characteristics of embodiments will be described with reference to FIG. **6**. For reference, the present drawings illustrate the dust collector **100** applied to an upright type vacuum cleaner **10**, but the dust collector **100** may not be necessarily limited to the upright type vacuum cleaner **10**. The dust collector **100** according to embodiments may also be applicable to a canister type vacuum cleaner **10**.

Referring to the above drawings, air and foreign substances generated from the fan unit of the vacuum cleaner **10** may be introduced to an entrance **100***a* of the dust collector **100** through the suction unit **12** by suction power generated by the fan unit of the vacuum cleaner **10**. The air introduced to the entrance **100***a* may be sequentially filtered at the first cyclone **110** and second cyclone **120** while flowing along a passage, and discharged through an exit **100***b*. Dust and fine dust separated from the air may be collected into a dust storage unit or compartment (D**1**) and a fine dust storage unit or compartment (D**2**) of the dust collector **100** which will be described later.

A cyclone may refer to an apparatus for providing rotational flow to a medium in which particles are floating to separate particles from the medium by a centrifugal force. The cyclone may separate foreign substances such as dust, fine dust, and the like from air introduced to an inside of the cleaner body **11** by suction power. According to the present specification, relatively large substances may be referred to as "dust," and relatively small substances may be referred to as "fine dust," and dust smaller than "fine dust" may be referred to as "ultra-fine dust."

The dust collector **100** may include an outer case **101**, the first cyclone **110**, the second cyclone **120** and a guide vane **123**. The outer case **101** may form a lateral appearance of the dust collector **100**. The outer case **101** may be formed in a cylindrical shape as illustrated in the drawing, but may not necessarily be limited to this. For example, the outer case **101** may also be formed in a polygonal columnar shape.

The entrance **100***a* of the dust collector **100** may be formed on the outer case **101**. The entrance **100***a* may be formed to be extended toward an inner circumference of the outer case **101** to allow air and foreign substances to be tangentially introduced into the outer case **101** and revolved along the inner circumference of the outer case **101**. As illustrated in the drawing, the entrance **100***a* may be formed at an upper portion of the outer case **101**.

Air and foreign substances may rotate in a first direction along an inner circumference of the outer case **101**, and referring to FIG. **5**, an example is illustrated in which the flow of air containing foreign substances may rotate in a clockwise direction. The first direction may coincide with a rotational flow direction when air and fine dust that have passed through the first cyclone **110** are introduced to an inside of the second cyclone **120**, and the structure of the guide vane **123**.

The first cyclone **110** may be installed within the outer case **101**. The first cyclone **110** may be configured to filter out dust from air introduced along with foreign substances, and collect the filtered dust in the dust storage unit (D**1**). As illustrated in the drawing, the first cyclone **110** may be arranged at an upper portion within the outer case **101**.

The first cyclone **110** may include a housing **111** and a mesh filter **112**. The housing **111** forms an outer appearance of the first cyclone **110**, and may be formed in a cylindrical shape similar to the outer case **101**. The housing **111** may be provided at an upper portion of the outer case **101**, wherein the housing **111** may be integrally formed with the outer case **101** or configured to be coupled to the outer case **101**.

The housing **111** may be formed in a shape in which an inside of the housing is hollow to accommodate the second cyclone **120**. An opening portion or an opening **111***b* communicating with an inside of the housing **111** may be formed on an outer circumference thereof. The opening portion **111***b* may be formed at a plurality of positions along the outer circumference of the housing **111** as illustrated in the drawing.

The casing **121** of the second cyclone **120** may be installed to pass through the bottom surface **111***d* of the first cyclone **110**, and to this end a through hole **111***d'* may be formed on the bottom surface **111***d* of the first cyclone **110**. FIG. **3** illustrates an example in which the bottom surface **111***d* provided with a through hole **111***d'* may be integrally formed with the housing **111**. The housing **111** may be extended with the same cross-sectional area along a downward direction as illustrated in the drawing, but may have a structure of gradually narrowing downward.

The mesh filter **112** may be installed on the housing **111** to cover the opening portion **111***b*, and may have a mesh or porous shape to allow air to pass therethrough. The mesh filter **112** may be formed to separate dust from air introduced into the housing **111**. The criteria of separating dust from fine dust may be determined by the mesh filter **112**. Foreign substances having a size of being allowed to pass through the mesh filter **112** may be divided into fine dust, and foreign substances having a size of not being allowed to pass through the mesh filter **112** may be divided into dust.

Considering the process of separating dust by the first cyclone **110** in detail, air and foreign substances may be introduced into an annular space between the outer case **101** and first cyclone **110** through the entrance **100***a* of the dust collector **100** to rotationally move in the annular space. During this process, relatively heavy dust may gradually flow down while rotationally moving in a spiral shape in a space between the outer case **101** and first cyclone **110** by a centrifugal force. A skirt **111***c* may be formed in a protruding manner at a lower portion or end of the housing **111** along an outer circumference of the housing to prevent the scattering of dust collected in the dust storage unit (D**1**). Referring to FIG. **3**, an example is illustrated in which the skirt **111***c* may be extended in an inclined manner toward the lower side.

Air may be introduced into the housing **111** through the mesh filter **112** by suction power. Fine dust may be also introduced into the housing **111** along with the air. Referring to FIG. **4**, it may be possible to check the internal structure of the dust collector **100** and the flow of air and foreign substances within the dust collector **100**.

The second cyclone **120** may be arranged within the first cyclone **110**, wherein the second cyclone **120** may be configured to separate air and fine dust introduced into the second cyclone **120** through an inlet **120***a*. Contrary to a vertical arrangement in the related art in which the second cyclone is arranged on top of the first cyclone, the second cyclone **120** of this embodiment may be accommodated inside the first cyclone **110**, thereby reducing the height of the dust collector **100**. The second cyclone **120** may be formed not to protrude from an upper portion of the first cyclone **110**.

The second cyclone in the related art has a guide passage extended from one side thereof to allow air and fine dust to be tangentially introduced to an inside of the second cyclone to rotate along an inner circumference of the second cyclone, but the second cyclone **120** according to this embodiment may not have such a guide passage. Accordingly, the second cyclone **120** may have a circular shape when viewed from above.

The second cyclone **120** may be provided with a casing **121** forming an outer appearance of the second cyclone **120**, and the casing **121** may be formed in a cylindrical shape as a whole. The structure may be beneficial to secure a space of forming an upper and a lower mold of the casing **121** during the injection molding of the second cyclone **120**. Accordingly, the guide vane **123** may be integrally formed into the second cyclone **120**. In particular, the guide vane **123** may be integrally formed with the casing **121** and a vortex finder or chimney **122**.

A plurality of second cyclones **120** may be provided within the first cyclone **110**, and FIGS. **2** through **4** illustrate such an example in which four second cyclones **120** may be provided within the first cyclone **110**. In a case where a plurality of second cyclones **120** may be provided therein, the second cyclones **120** may be formed to be in contact with each other or arranged to be spaced from each other, and an example in which the second cyclones **120** are arranged to be spaced from each other at predetermined intervals is illustrated in the drawing. Meanwhile, a plurality of second cyclones **120** may be provided in parallel to each other to efficiently discharge fine dust and air.

The second cyclone **120** may be configured to collect and deposit relatively heavy fine dust into the fine dust storage unit (D**2**) through the outlet **120***b* in a downward direction while discharging air from which fine dust is separated in an upward direction. The outlet **120***b* may form a structure of discharging fine dust in a circumferential direction and a downward direction of the casing **121**, and may be beneficial in the performance of separating fine dust.

A cover **128** forming a bottom surface of the casing **121** may be mounted at a lower portion of the casing **121**. In order to integrally form the guide vane **123**, vortex finder **122** and casing **121**, a space for forming a mold (for an example, cavity or core) coupled to a lower portion of the casing **121** may be needed, and thus the cover **128** may be coupled to a lower portion of the casing **121** with an additional element. A discharge pipe **129** extended to an inside of the casing **121** may be provided at the center of the cover **128**, and a second discharge port **120***b***2** which will be described later may be formed at a lower portion of the discharge pipe **129**.

The inlet **120***a* that introduces air and fine dust may be formed at an upper portion within the casing **121**, and the vortex finder **122** that discharges air from which fine dust is filtered to an outside of the casing may be installed at an upper center within the casing **121**. The guide vane **123** may be provided in the inlet **120***a* between an inner circumference of the casing **121** and an outer circumference of the vortex finder **122**, and a specific structure associated with the guide vane **123** will be described later.

The second cyclone **120** may be installed to pass through the bottom surface **111***d* of the first cyclone **110**, and a through hole **111***d*' may be formed on the bottom surface **111***d*, and the casing **121** may be coupled to the through hole **111***d*'. The outlet **120***b* of the second cyclone **120** that discharges fine dust may be provided at a lower end portion of the casing **121**. An inner case **150** that accommodates the outlet **120***b* may be coupled to a lower portion of the first cyclone **110** to collect and deposit fine dust discharged from the outlet **120***b* into the fine dust storage unit (D**2**) within the inner case **150**.

The outlet **120***b* may be configured to communicate an inner space of the second cyclone **120** with the fine dust storage unit (D**2**). The outlet **120***b* may include a first outlet **120***b***1** to discharge fine dust to an outer circumferential portion of the casing **121** and a second outlet **120***b***2** for discharging fine dust in a downward direction of the casing **121**.

The first outlet **120***b***1** may be cut and formed on a lower outer circumference of the casing **121** to discharge fine dust rotationally flowing within the casing **121** to the inner case **150**. The first outlet **120***b***1** may be formed at a lower side of the bottom surface **111***d* of the first cyclone **110** to discharge fine dust to the fine dust storage unit (D**2**). The second outlet **120***b***2** may be formed at a lower portion of the discharge pipe **129** in the cover **128** forming a lower surface of the casing **121**.

Air containing fine dust introduced to an inside of the second cyclone **120** through the inlet **120***a* may induce rotational flow due to the guide vane **123**. Mainly, the first outlet **120***b***1** may be configured to discharge rotationally flowing fine dust, and the second outlet **120***b***2** may be configured to discharge fine dust dropping by its own weight.

A first portion **151** of inner case **150** may be coupled to the skirt **111***c* to allow the inner case **150** to accommodate the first and the second outlets **120***b***1**, **120***b***2** and collect fine dust. Furthermore, fine dust coming out of the first and the second outlets **120***b***1**, **120***b***2** and dust collected on an inner surface of the first portion **151** may eventually be collected into an inner space of a second portion **152** of the fine dust storage unit (D**2**). Part of the fine dust may also remain on an inner circumference of the first portion **151**.

Referring to FIGS. **4** and **5** together, a space between an inner circumference of the first cyclone **110** and an outer circumference of the second cyclone **120** is referred to as a first space (S**1**). The first space (S**1**) may form a passage capable of introducing air and fine dust introduced to an inside of the first cyclone **110** to an upper portion of the second cyclone **120**. The cover member **130** may be provided at an upper portion of the second cyclone **120**, and the cover member **130** may be provided to cover the inlet **120***a* of the second cyclone **120** at predetermined intervals to form a second space (S**2**) communicating the first space (S**1**) with the inlet **120***a*. According to the communication relationship, air introduced into the first cyclone **110** may be introduced into the inlet **120***a* at an upper portion of the second cyclone **120** through the first space (S**1**) and second space (S**2**).

As described above, the entrance **100***a* of the outer case **101** may be extended toward an inner circumference of the outer case **101** to rotate air in the first direction. FIG. **5** illustrates an example in which air rotates in a clockwise direction. Air containing fine dust may move upward in the first space (S**1**) and may pass through the second space (S**2**) to be introduced to the inlet **120***a* of the second cyclone, and the guide vane **123** may be formed with a structure configured to slope in the same direction as the first direction and angle downward to enhance the rotational flow performance of the introduced air.

The vortex finder **122** configured to discharge air from which fine dust has been separated may be provided at the center of an upper portion of the second cyclone **120**. Due to the upper structure, the inlet **120***a* may be defined as an annular space between an inner circumference of the second cyclone **120** and an outer circumference of the vortex finder **122**. The guide vane **123** which may extend in a spiral shape along an inner circumference may be provided at or in the inlet **120***a* of the second cyclone **120**. According to the embodiment, the guide vane **123** may be integrally formed with the vortex finder **122** and casing **121**. As described above, the casing **121** may have a cylindrical shape, and a lower surface of the casing **121** may be configured with a cover **128**, which may be an additional member.

As the guide vane **123** may be integrally formed with the vortex finder **122** and casing **121** an additional process of coupling the guide vane **123** to an inner circumference of the casing **121** may not be required, which is a necessary process in a case where the guide vane **123** is configured as an additional member to the casing **121**. This may reduce the manufacturing cost and manufacturing time of the vacuum cleaner.

Rotational flow may be generated in air introduced to an inside of the second cyclone **120** through the inlet **120***a* by the guide vane **123**. Considering the flow of air and fine dust introduced into the inlet **120***a* in detail, the fine dust may flow down while rotationally moving in a spiral shape along an inner circumference of the second cyclone **120**, and may eventually be discharged through the outlet **120***b* and collected in the fine dust storage unit (D**2**).

Relatively light air compared to fine dust may be discharged to the vortex finder **122** at an upper portion of the second cyclone **120** by suction power. Meanwhile, a plurality of ribs that extend in a radial direction may be provided on an inner circumference of the vortex finder **122** to mitigate the rotational flow of the discharged air. The plurality of ribs may be installed to be spaced from each other at predetermined intervals along the inner circumference of the vortex finder **122**.

According to a structure in which the guide vane **123** is provided between the vortex finder **122** and the casing **121** as described above, contrary to the related art in which high-speed rotational flow is generated while being biased to one side by the guide passage, relatively uniform rotational flow may be generated over substantially an entire region. Accordingly, local high-speed flow may not be generated compared to the structure of the second cyclone in the related art, thereby reducing the flow loss due to this.

A plurality of guide vanes **123** may be arranged to be spaced from each other at predetermined intervals along an outer circumference of the vortex finder **122**. Each of the guide vanes **123** may be configured to be started from the same first height **123***b***1** and extended to the same second height **123***b***2** on an outer circumference of the vortex finder **122**. FIG. **6** illustrates an example in which the first position **123***b***1** is located higher than the second position **123***b***2**. The guide vane **123** may be formed in an inclined manner downward along the first direction to further enhance the rotational flow of air inside the second cyclone **120**. The guide vane **123** may have a structure that rotates air and fine dust in the first direction to move them downward, and such a structure may minimize the loss of rotational flow in the guide vane **123**.

Referring to FIG. **6**, an example is illustrated in which the guide vane **123** may be formed in an inclined manner downward along a clockwise direction. Four guide vanes **123** may be arranged at 90° intervals along an outer circumference of the vortex finder **122**. A larger number of the guide vanes **123** may be provided compared to the illustrated example, and at least part of any one guide vane **123** may be positioned to overlap with another guide vane **123** in a vertical direction of the vortex finder **122**.

A lower diameter of the vortex finder **122** may be formed to be less than an upper diameter thereof. According to the foregoing shape, an area of the inlet **120***a* may be decreased from an upper portion to a lower portion to increase a speed of air flowing into the second cyclone **120**, and fine dust introduced into the second cyclone **120** may be limited from being discharged through the vortex finder **122** along with air. Further, the vortex finder **122** may have a taper portion having a diameter that gradually decreases toward a lower end of the vortex finder **122**.

An upper cover **140** may be provided on the cover member **130** to form a discharge passage to discharge air discharged through the communication hole **130***a* to an outside of the dust collector **100**. The exit **100***b* of the dust collector **100** may be formed on the upper cover **140** to discharge air. The upper cover **140** may form an upper appearance of the dust collector **100**. Air discharged through the exit **100***b* of the dust collector **100** may be discharged through an exhaust port of the cleaner body **11** to an outside of the cleaner body **11**.

A porous pre-filter **145** configured to filter out ultra-fine dust from air may be installed on a passage extended from the exit **100***b* of the dust collector **100** to the exhaust port of the cleaner body **11**. The casing **121** of the second cyclone **120** may be installed to pass through a bottom surface **111***d* of the first cyclone **110**. A through hole **111***d'* for the insertion of the second cyclone **120** may be formed on the bottom surface **111***d* of the first cyclone **110**.

As described above, the inner case **150** accommodating the outlet **120***b* may be installed at a lower portion of the first cyclone **110** to form the fine dust storage unit (D**2**) for collecting fine dust discharged through the outlet **120***b*. A lower cover **160** which will be described later forms a bottom surface of the fine dust storage unit (D**2**). Dust filtered out through the first cyclone **110** is collected into the dust storage unit (D**1**) between an inner circumference of the outer case **101** and an outer circumference of the inner case **150**. The bottom surface of the dust storage unit (D**1**) may be formed by the lower cover **160**.

Referring to FIG. **3**, both the dust storage unit (D**1**) and fine dust storage unit (D**2**) may be formed to be open toward a lower portion of the outer case **101**. The lower cover **160** may be coupled to the outer case **101** to cover an opening portion of the dust storage unit (D**1**) and fine dust storage unit (D**2**) so as to form a bottom surface of the dust storage unit (D**1**) and fine dust storage unit (D**2**). As described above, the lower cover **160** may be coupled to the outer case **101** to open or close a lower portion thereof. According to the present embodiment, the lower cover **160** may be coupled to the outer case **101** through a hinge **161** to open or close a lower portion of the outer case **101** according to the rotation thereof. However, embodiments may not necessarily be limited to this, and the lower cover **160** may also be coupled to the outer case **101** in a completely detachable manner.

The lower cover **160** may be coupled to the outer case **101** to form a bottom surface of the dust storage unit (D**1**) and fine dust storage unit (D**2**). The lower cover **160** may be rotated by the hinge **161** to discharge dust and fine dust at the same time so as to open the dust storage unit (D**1**) and fine dust storage unit (D**2**) at the same time. When the lower cover **160** is rotated by the hinge **161** to open the dust storage unit (D**1**) and fine dust storage unit (D**2**) at the same time, it may be possible to discharge dust and fine dust at the same time.

A plurality of ribs **103** for dust collection may be formed in a protruding manner on an inner circumference of the outer case **101** to collect the dust introduced into the dust storage unit (D**1**), and the ribs **103** for dust collection may be protruded toward the center of the outer case **101**, for an example. A plurality of ribs **103** may be provided for dust collection, and in this case, they may be installed to be spaced from each other at predetermined intervals along an inner circumference of the outer case **101**. The ribs **103** for dust collection may prevent dust collected in the dust storage unit (D**1**) from being rotated by the rotational flow of air introduced from an outside thereof, and prevent dust from being scattered or discharged to an unintentional place during the process of discharging dust, thereby facilitating the discharge of dust.

FIG. **7** is a longitudinal cross-sectional view illustrating an example of a dust collector **200** according to another embodiment. Referring to FIG. **7**, the dust collector **200** according to another embodiment will be described.

The dust collector **200** according to another embodiment has a difference in providing an upward passage vane **223***a* between the first cyclone **210** and the second cyclone **220**. The upward passage vane **223***a* spirally extends into a first space (S**1**) between the first cyclone **210** and the second cyclone **220** to induce rotational flow so as to introduce air to the inlet **220***a* of the second cyclone **220**. A plurality of upward passage vanes **223***a* may be provided thereon, and arranged to be spaced from each other at predetermined intervals on an outer circumference of the casing **221**.

When a plurality of second cyclones **220** are provided therein, the upward passage vane **223***a* may be provided at or in a first space (S**1**) between the first cyclone **210** and a second cyclone **220** and a space between two second cyclones **220**. Meanwhile, when one second cyclone **220** is provided therein, the upward passage vane **223***a* is provided at or in the first space (S**1**). FIG. **7** illustrates an example in which a plurality of second cyclones **220** are provided therein and the upward passage vane **223***a* is provided at or in a first space (S**1**) and a space between two second cyclones **220**.

As described above, air containing dust may be introduced to an inside of the outer case **201** through the entrance **200***a* to revolve in one direction, and the upward passage vane **223***a* may be formed in an inclined manner upward along the first direction to move fine dust containing air that has passed the mesh filter **212** upward while rotating in the first direction. The guide vane **223** formed in an inclined manner downward along the first direction has been described in the description of the dust collector **200** according to an embodiment.

Air that has passed through the first cyclone **110** may be easily introduced to the second cyclone **120** by the upward passage vane **223***a* without forming an additional passage on the inlet **120***a* of the second cyclone **120**, thereby reducing introduction loss between the first cyclone **110** and the second cyclone **120**. Furthermore, air that has passed the upward passage vane **223***a* may induce rotational flow, and enhance rotational flow while passing through the guide vane **123**, thereby enhancing the separation performance of fine dust within the second cyclone **220**.

According to the foregoing configuration, the second cyclone may be accommodated into the first cyclone, thereby reducing the height of the dust collector. A guide vane may be installed on an inlet of the second cyclone. The guide vane may be configured to induce rotational flow to air introduced to an inside of the second cyclone through the first and the second space. Accordingly, an additional guide passage extended from one side of the second cyclone is not required, thereby reducing passage loss during the introduction of air into the second cyclone.

A larger number of second cyclones may be arranged within the first cyclone. Accordingly, it may be possible to prevent the degradation of cleaning performance due to the arrangement in the second cyclone. A guide vane installed at an inlet of the second cyclone may strengthen rotational flow to air introduced to an inside of the second cyclone to enhance the separation performance of fine dust within the second cyclone. In this manner, the degradation of collection performance in a multi-cyclone may be prevented by the guide vane.

The guide vane may be integrally formed with the casing and vortex finder. A process of coupling one side of the guide vane to the casing may be omitted, thereby reducing the manufacturing cost and time. A dust storage unit and a fine dust storage unit may be configured to be both open during the separation of a lower cover, thereby discharging dust collected in the dust storage unit and fine dust collected in the fine dust storage unit at the same time during the opening.

A dust collector for a vacuum cleaner with a new structure in which a multi-cyclone structure is improved to lower down the height without reducing the cleaning performance is provided. A dust collector for efficiently introducing air that has passed through the first cyclone to the second cyclone as well as further enhancing the rotational flow of air introduced into the second cyclone is provided. A cyclone structure capable of facilitating the manufacture as well as reducing the manufacturing cost and time is also provided. A dust collector capable of collecting dust and fine dust in a separate manner as well as easily discharging them at the same time is also provided.

A dust collector for a vacuum cleaner may include a first cyclone provided within an outer case to filter out dust from air introduced from an outside thereof and introduce the air from which dust has been filtered out to an inside thereof, a second cyclone accommodated in the inside of the first cyclone to form a first space between the first cyclone and the second cyclone to separate fine dust from the air introduced to the inside of the first cyclone, and a guide vane spirally extended along an inner circumference of the second cyclone to induce rotational flow to the air introduced to an inside of the second cyclone through an inlet of the second cyclone via the first space, wherein the guide vane is integrally provided on the second cyclone. The second cyclone may include a cylindrically shaped casing forming an outer appearance, and a vortex finder provided at the center of the second cyclone to discharge air from which fine dust has been separated, wherein the guide vane is integrally formed with the casing and vortex finder on the inlet limited between an inner circumference of the casing and an outer circumference of the vortex finder.

A plurality of guide vanes may be provided and positioned to be spaced from each other at predetermined intervals along an outer circumference of the vortex finder. An entrance extended toward an inner circumference of the outer case may be formed at an upper portion of the outer case to rotate air introduced from an outside thereof in a first direction, and the guide vane may be formed in an inclined manner downward along the first direction to rotate air introduced into the inlet through the first space downward in the first direction to be introduced to an inside of the second cyclone.

The casing may be installed to pass through a bottom surface of the first cyclone, and an inner case provided with a fine dust storage unit configured to collect fine dust may be coupled to a lower portion of the first cyclone, and an outlet communicating an inside of the second cyclone with the fine dust storage unit to discharge fine dust to the fine dust storage unit may be provided on the second cyclone. The outlet may include a first outlet cut and formed on an outer circumference of a lower side of the casing to discharge fine dust in an outer circumferential direction of the casing, and a second outlet formed at the center of a lower side of the casing to discharge fine dust in a downward direction of the casing, wherein the inner case accommodates the first and the second outlet to collect fine dust discharged from the first and the second outlet into the fine dust storage unit.

A cover forming a bottom surface of the casing may be mounted at a lower portion of the casing, and a discharge pipe formed with the second outlet may be provided at the center of the cover. A skirt may be formed in a protruding manner along an outer circumferential surface at a lower portion of the first cyclone, and the inner case may be coupled to the skirt. The inner case may include a first portion coupled to the skirt and formed in a tapering manner downward, and a second portion extended downward from the first portion and arranged in a direction parallel to the outer case.

The first cyclone may include a housing formed to accommodate the second cyclone therein, and provided with an opening portion communicating with an inside on an outer circumference thereof, and a mesh filter installed to cover the opening portion to filter out and separate the dust from the air. An inner case configured to collect fine dust discharged from the second cyclone may be installed at a lower portion of the housing, and dust filtered out through the mesh filter may be collected into a dust storage unit between an inner circumference of the outer case and an outer circumference of the inner case.

The dust collector for a vacuum cleaner may further include a lower cover hinge-coupled to the outer case to form a bottom surface of the outer case and the inner case during the closing, and discharge dust collected in the dust storage unit and fine dust collected in the fine dust storage unit at the same time during the opening. The second cyclone may be accommodated into the first cyclone to reduce the height of the collector.

A guide vane may be installed on an inlet of the second cyclone. The guide vane may be configured to induce rotational flow to air introduced to an inside of the second cyclone through the first and the second space. Accordingly, an additional guide passage extended from one side of the second cyclone may not be required, thereby reducing passage loss during the introduction of air from the second cyclone.

A larger number of second cyclones may be arranged within the first cyclone. Accordingly, it may be possible to prevent the degradation of cleaning performance due to the arrangement in the second cyclone. A guide vane installed at an inlet of the second cyclone may strengthen rotational flow to air introduced to an inside of the second cyclone to enhance the separation performance of fine dust within the second cyclone. In this manner, the degradation of collection performance in a multi-cyclone may be prevented by the guide vane.

The guide vane may be integrally formed with the casing and vortex finder. A process of coupling one side of the guide vane to the casing may be omitted, thereby reducing the manufacturing cost and time. A dust storage unit and a fine dust storage unit may be configured to be both open during the separation of a lower cover, thereby discharging dust collected in the dust storage unit and fine dust collected in the fine dust storage unit at the same time during the opening.

The terms including an ordinal number such as first, second, etc. can be used to describe various elements, but the elements should not be limited by those terms. The terms are used merely for the purpose to distinguish an element from the other element.

In case where an element is "connected" or "linked" to the other element, it may be directly connected or linked to the other element, but also should be understood that another element may exist therebetween.

Unless clearly used otherwise, expressions in the singular number include a plural meaning.

In this application, the term "comprising," "including," or the like, intend to express the existence of the characteristic, the numeral, the step, the operation, the element, the part, or the combination thereof, and do not intend to exclude another characteristic, numeral, step, operation, element, part, or any combination thereof, or any addition thereto.

Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A vacuum cleaner having a dust collector, the dust collector comprising:

a first cyclone provided within an outer case to filter out dust from air introduced from an outside of the outer case; and

at least one second cyclone accommodated inside of the first cyclone to form a first space between the first cyclone and the at least one second cyclone, wherein the at least one second cyclone separates fine dust from the air introduced to the inside of the first cyclone, and wherein the at least one second cyclone includes:

a cylindrically shaped casing having a first outlet formed on an outer circumference of a lower side of the casing to discharge fine dust in an outer circumferential direction of the casing;

a vortex finder provided at a center of an upper portion of the casing and through which air from which fine dust has been separated is discharged;

at least one guide vane spirally extended along an inner circumference of the casing to induce rotational flow of the air introduced to an inside of the casing through an inlet between the casing and the vortex finder via the first space, wherein the at least one guide vane is integrally formed with the casing and the vortex finder; and

a cover mounted at a lower portion of the casing and having a discharge pipe formed with a second outlet to discharge fine dust in a downward direction of the casing, the discharge pipe being provided at a center of the cover, wherein the first outlet and the second outlet are open in directions perpendicular to each other.

2. The vacuum cleaner of claim **1**, wherein the at least one guide vane includes a plurality of guide vanes provided to be spaced from each other at predetermined intervals along an outer circumference of the vortex finder.

3. The vacuum cleaner of claim **2**, wherein an air entrance extended toward an inner circumference of the outer case is formed at an upper portion of the outer case to rotate air introduced from an outside of the outer case in a first direction, and wherein the plurality of guide vanes are formed in an inclined manner downward along the first direction to rotate air introduced into the inlet of the second cyclone through the first space downward in the first direction to be introduced to an inside of the second cyclone.

4. The vacuum cleaner of claim **1**, wherein the casing passes through the bottom surface of the first cyclone, wherein an inner case provided with a fine dust storage compartment configured to collect fine dust is coupled to a lower portion of the first cyclone, and wherein the first and second outlets communicate with the fine dust storage compartment.

5. The vacuum cleaner of claim **4**, wherein a skirt is formed in a protruding manner along an outer circumferential surface of a lower portion of the first cyclone, and wherein the inner case is coupled to the skirt.

6. The vacuum cleaner of claim **5**, wherein the inner case includes:

a first portion coupled to the skirt and formed in a tapering manner downward; and

a second portion extended downward from the first portion and arranged in a direction parallel to the outer case.

7. The vacuum cleaner of claim **1**, wherein the first cyclone includes:

a housing formed to accommodate the second cyclone therein, and provided with an opening portion communicating with an inside on an outer circumference thereof; and

a mesh filter installed to cover the opening portion to filter out and separate the dust from the air.

8. The vacuum cleaner of claim **7**, wherein an inner case configured to collect fine dust discharged from the second cyclone is installed at a lower portion of the housing, and dust filtered out through the mesh filter is collected into a dust storage compartment between an inner circumference of the outer case and an outer circumference of the inner case.

9. The vacuum cleaner of claim **8**, further including:

a lower cover that is hinge-coupled to the outer case to form a bottom surface of the outer case and the inner case in a closed position, and discharge dust collected in the dust storage compartment and fine dust collected in the fine dust storage compartment at the same time when opened.

10. A vacuum cleaner having a dust collector, the dust collector comprising:

a first cyclone provided within an outer case to filter out dust from air introduced from an outside of the outer case;

at least one second cyclone accommodated inside of the first cyclone and forming a first space between the first cyclone and the at least one second cyclone, wherein the at least one second cyclone separates fine dust from the air introduced to the inside of the first cyclone;

at least one guide vane spirally extended along an inner circumference of the at least one second cyclone to induce rotational flow of the air introduced to an inside of the at least one second cyclone through an inlet of the second cyclone via the first space, wherein the at least one guide vane is integrally provided on the at least one second cyclone;

a first discharge port located at a lower portion of an outer circumferential surface of the at least one second cyclone; and

a second discharge port located on a bottom surface of the at least one second cyclone,

wherein the first discharge port and the second discharge port are open in directions perpendicular to each other.

11. The vacuum cleaner of claim **10**, wherein the at least one second cyclone includes:

a cylindrically shaped casing; and

a vortex finder provided within the casing at the center of the at least one second cyclone to discharge air from which fine dust has been separated, wherein the at least one guide vane is integrally formed with the casing and vortex finder on the inlet between an inner circumference of the casing and an outer circumference of the vortex finder.

12. The vacuum cleaner of claim **11**, wherein the at least one guide vane includes a plurality of guide vanes provided to be spaced from each other at predetermined intervals along an outer circumference of the vortex finder.

13. The vacuum cleaner of claim **12**, wherein an air entrance extended toward an inner circumference of the outer case is formed at an upper portion of the outer case to rotate air introduced from an outside of the outer case in a first direction, and wherein the plurality of guide vanes are formed in an inclined manner downward along the first direction to rotate air introduced into the inlet of the second cyclone through the first space downward in the first direction to be introduced to an inside of the second cyclone.

14. The vacuum cleaner of claim **11**, wherein the casing passes through a bottom surface of the first cyclone, and wherein an inner case provided with a fine dust storage compartment configured to collect fine dust is coupled to a lower portion of the first cyclone.

15. The vacuum cleaner of claim **14**, wherein both the first discharge port and the second discharge port are configured to discharge fine dust into the inner case.

16. The vacuum cleaner of claim **15**, wherein a skirt is formed in a protruding manner along an outer circumferential surface of a lower portion of the first cyclone, and wherein the inner case is coupled to the skirt, and wherein the inner case includes:

a first portion coupled to the skirt and formed in a tapering manner downward; and

a second portion extended downward from the first portion and arranged in a direction parallel to the outer case.

17. The vacuum cleaner of claim **10**, wherein the first cyclone includes:

a housing formed to accommodate the second cyclone therein, and provided with an opening portion communicating with an inside on an outer circumference thereof; and

a mesh filter installed to cover the opening portion to filter out and separate the dust from the air.

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